

# The Transverse Carpal Ligament: Anatomy and Clinical Implications

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## Abstract

### Keywords

- transverse carpal ligament
- carpal tunnel
- carpal tunnel syndrome

The anatomical characteristics of the transverse carpal ligament (TCL) have recently been further clarified. Its bony insertion sites proximally to the scaphoid and pisiform are more round, whereas the distal insertion sites to the trapezium and hamate are more oblong, with reproducible areas of insertion. The thickness of the TCL varies along the path of the median nerve, with the thickest portions distal ulnarly and proximal radially. The predominant fiber orientation is transverse. This more detailed understanding of the anatomy of the TCL may enable more novel treatments of carpal tunnel syndrome.

Surgery for carpal tunnel syndrome (CTS) has been performed for decades and generally has involved release of the transverse carpal ligament (TCL) to expand the carpal tunnel volume and decrease compression on the median nerve. Although this surgery is the most common procedure on the upper extremity, only recently have investigators studied the TCL in a rigorous fashion to understand its anatomical complexity. This article summarizes our current knowledge of the boundaries of the TCL, its morphology, and its clinical implications.

## Definition

The TCL is the middle portion of the flexor retinaculum (FR).<sup>1</sup> The proximal portion of the FR is the distal continuation of the antebrachial fascia.<sup>2</sup> The transition from the antebrachial fascia to the TCL can be identified based on gross inspection, predominantly marked by the abrupt increase in thickness. Also, the fiber orientation of the antebrachial fascia is longitudinal and abruptly changes to transverse in the TCL. The distal portion of the FR is separated from the TCL by a thin layer of adipose tissue.<sup>3</sup> Its fibers run transversely between the thenar and hypothenar musculature.

## Anatomic Boundaries of the TCL

Manley et al recently characterized the carpal bone attachment sites and identified a consistent footprint on the

scaphoid and trapezium radially and the pisiform and hamate ulnarly.<sup>4</sup> They found the distal insertion sites to be longer and more oblong, approximating a 2:1 ratio of length to width, whereas the more proximal scaphoid and pisiform insertion sites approximated a 1:1 ratio. The average insertion of the TCL on the scaphoid was 6 × 6 mm, trapezium 13 × 6 mm, pisiform 9 × 6 mm, and hamate 11 × 5 mm.

In addition, three muscles are known to originate from the TCL. Radially, a large portion of the abductor pollicis brevis and a lesser portion of the flexor pollicis brevis originates from the TCL. Ulnarly, a portion of the flexor digiti minimi brevis originates from the TCL.

## Morphology of TCL

Initial morphometric studies of the TCL by Tanzer examined the central portion and noted the TCL to thicken from proximal to distal, ranging in thickness from 1.5 mm to 6.0 mm.<sup>5</sup> The large variation in thickness can be accounted for by including the distal aponeurosis in their measurement. Cobb et al used photographic measurements and found a variation in thickness from 0.8 to 2.5 mm.<sup>2</sup> Pacek et al used a silicone casting technique to examine TCL morphology in cadaveric hands.<sup>1</sup> The length of the TCL in the longitudinal direction was shortest in the midline at 14.4 mm, whereas the radial and ulnar lengths were 16.5 mm and 15.1 mm, respectively. The mean thickness of the TCL was 2.1 mm, thickest distally in the midline and along the ulnar border,

and proximally along the radial border. Conversely, the TCL was thinnest proximal ulnarly and distal radially. The cross-sectional area of the radial and ulnar portions of the TCL was significantly larger than the midline portion.

### Fiber Orientation of TCL

The predominant fiber orientation of the TCL is transverse. Prantil et al performed a rigorous evaluation of collagen fiber orientation using a small-angle light-scattering technique.<sup>6</sup> Overall, their data indicated that >60% of the TCL collagen fibers were oriented transversely. Pisiform-trapezium oblique orientation were next most common at 18.6%, scaphoid-hamate oblique was 13% and longitudinal fiber orientation accounted for 8.6%. Although Isogai et al reported a fiber laminar configuration that varied by depth of the ligament by an observational study,<sup>7</sup> Prantil et al showed no fiber variation with depth.<sup>6</sup>

### Clinical Significance

Current trends in the surgical management of CTS include more limited exposure and endoscopic techniques for release of the TCL. An intimate understanding of the boundaries and extent of the TCL is paramount for its optimal and safe release. Knowledge of the distal extent of the TCL ensures safe complete distal release, often implicated in failed CTR. In addition, release of the TCL along its ulnar border may decrease the incidence of inadvertent injury to the recurrent branch of the median nerve, which is more radial, but it does risk injury of the ulnar motor branch as it courses around the hook of the hamate. In addition, this understanding has led to novel indirect release techniques of the TCL, such as during thumb basal joint arthroplasty.<sup>8</sup> Excision of the trapezium releases one attachment site of the radial TCL, and more proximal release from its scaphoid tubercle through the same incision allows complete TCL release and diminished carpal tunnel pressure.

Although release of the TCL is currently the mainstay of treatment for CTS, a more in-depth knowledge of the morphology of the ligament may make more novel nonoperative treatments possible. For instance, as the median nerve traverses from proximal to distal, the TCL thickens in the midline and ulnarly. This variation in normal thickness, with or without further pathologic thickening in this area, has been

implicated as a potential cause for median nerve compressive neuropathy.<sup>1</sup> In addition, some authors have suggested that an understanding of the thinner portion of the TCL radial distally and its more elastic properties may enable mechanical treatments to stretch the TCL and alleviate the compressive neuropathy to the median nerve.<sup>9</sup> Further dynamic studies with ultrasound may better enable investigators to assess the effect of carpal bone stresses on the volume of the carpal tunnel and may lead to other nonoperative treatment options.<sup>10</sup>

#### Note

Work performed at the University of Pittsburgh Medical Center and Cleveland Clinic

#### Conflict of Interest

None

### References

- 1 Pacek CA, Chakan M, Goitz RJ, Kaufmann RA, Li ZM. Morphological analysis of the transverse carpal ligament. *Hand (NY)* 2010;5(2): 135–140
- 2 Cobb TK, Dalley BK, Posteraro RH, Lewis RC. Anatomy of the flexor retinaculum. *J Hand Surg Am* 1993;18(1):91–99
- 3 Tanabe T, Okutsu I. An anatomical study of the palmar ligamentous structures of the carpal canal. *J Hand Surg [Br]* 1997;22(6): 754–757
- 4 Manley M, Boardman M, Goitz RJ. The carpal insertions of the transverse carpal ligament. *J Hand Surg* 2013;38:729–732
- 5 Tanzer RC. The carpal-tunnel syndrome; a clinical and anatomical study. *J Bone Joint Surg Am* 1959;41-A(4):626–634
- 6 Prantil RK, Xiu K, Kim KE, et al. Fiber orientation of the transverse carpal ligament. *Clin Anat* 2012;25(4):478–482
- 7 Isogai S, Murakami G, Wada T, Akita K, Yamashita T, Ishii S. Laminar configuration of the transverse carpal ligament. *J Orthop Sci* 2002; 7(1):79–83
- 8 Cassidy C, Glennon PE, Stein AB, Ruby LK. Basal joint arthroplasty and carpal tunnel release through a single incision: an in vitro study. *J Hand Surg Am* 2004;29(6):1085–1088
- 9 Brett AW, Oliver ML, Agur AM, Edwards AM, Gordon KD. Quantification of the transverse carpal ligament elastic properties by sex and region. *Clin Biomech (Bristol, Avon)* 2014;29(6):601–606
- 10 Shen ZL, Li ZM. Ultrasound assessment of transverse carpal ligament thickness: a validity and reliability study. *Ultrasound Med Biol* 2012;38(6):982–988